A GENDER EFFECT RELATED TO TEACHERS' CONCEPTIONS ON BIOLOGICAL GENDER DIFFERENCES. A SURVEY IN 14 COUNTRIES

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Abstract:

In the context of the European research project Biohead-Citizen, 5,706 in-service and pre-service teachers from 14 countries (most in Europe, but also in Africa and Middle East) filled in a questionnaire containing 16 questions mainly related to the existence and to the origins of differences between men and women.
We analyse the teachers' answers on biological gender differences, as possible interactions between their scientific knowledge (K) and values (V). Nine questions were focused on possible KV interactions, dealing with biological and / or social differences between men and women. Five questions were related only to scientific knowledge and two questions only to values. In each country we applied the questionnaire to six different samples : pre-service and in-service primary schools teachers , and biology and national language upper schools teachers . The answers were submitted to multivariate analyses.
The results confirm that biology teachers have more scientific knowledge on this issue than their colleagues. Nevertheless, the answers to questions related to sexist or hereditarianist values show very significant differences among countries, the less economically developed countries being more sexist than the other ones. There is a significant gender effect for the sexist variables. The ratio men / women being different from one country to another, and inside the six samples in each country, we suppressed these two effects to show that the gender effect is still significant independently to these variables. Female teachers are significantly less sexist than their male colleagues.

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1.Introduction

The innatism is still present in our society even if the debate between nature and nurture is outdated, both being necessarily in constant interaction (Stewart 1993, Atlan 1999, Jacquard & Kahn 2001, Kupiec & Sonigo 2001). Canguilhem (1981), philosopher of biology, defined the explanation of complex social features by only the human genes as a reductionist ideology inside Life Sciences. Recent research (as Keller 2005 in Germany or Dambrun 2007 in France) emphasized again that this ideology engenders intolerant attitudes (sexism, racism).
Today, in most of the European countries, the feminist positions that try to develop more equality between men and women are well accepted, even if there are still important gender differences in their social positions (INSEE and Eurostat, in Chemin 2007).
In this context, we (?) decided to analyse teachers' conceptions on gender differences, in terms of biological and / or social determinism, in contrasted countries, from Northern European ones, known for their feminist values and practices to the Mediterranean ones known for their traditional sexism (or "machismo"), including countries from West and East Europe (with their different recent stories), Middle East (Cyprus, Lebanon), North or South of the Mediterranean Sea and also two sub - Saharan countries.

2.Theoretical background

Most of the recent gender issues related to science education, focused on the gender difference in attractiveness to science (Sorensen 2007). Large international surveys showed some gender differences in students' performances (PISA, 2003), or analysed possible gender differences in students' preferred content areas in science and youth's identity construction (ROSE: e.g. Schreiner & Sjoberg 2007). Nevertheless, the gender was often the only personal parameter taken into account, and the observed gender differences, even when significant, could be a consequence of other characteristics influencing the analysed samples.
Our work is focused on the biological and social differences between men and women, including some questions related to innate determinism of some human beings features, and to scientific knowledge on genetic determinism and cerebral epigenesis. Our theoretical background is the KVP model (Clément 2004, 2006), analysing teachers' conceptions as possible interactions between scientific knowledge (K), values (V) and social practices (P).

3. Research Questions

1) Do teachers' conceptions on gender differences vary according to their scientific knowledge, or according to their values? Is there an interaction between their knowledge and their values?

2) Do their conceptions vary with controlled personal parameters? In the present paper, we specifically analyze eventual influences of the following parameters: nationality, gender and biologist or non-biologist teachers.

4.Methodology

Our paper presents part of the results obtained from a questionnaire filled by precise samples of pre-service and in-service teachers from 14 countries in the context of an European research project: BIOHEAD-CITIZEN (2004-2008).

4.1.Samples

5,706 individuals filled in the questionnaire in 14 countries: 322 in Cyprus (CY), 183 in Estonia (ES), 306 in Finland (FI), 732 in France (FR), 334 in Hungary (HU), 559 in Italy (IT), 722 in the Lebanon (LB), 330 in Morocco (MO), 351 in Portugal (PT), 273 in Rumania (RO), 324 in Senegal (SN), 296 Burkina Faso (BF), 223 in Algeria (DZ) and 753 in Tunisia (TN). Six categories of samples were defined in each country: in-service primary school teachers, in-service biology secondary school teachers or in-service secondary school teachers of language and also pre-service primary school teachers and pre service secondary school teachers in biology or in language (see table 1).

Country	In-service			Pre-service			Female	Male
	Bio	Letters	Primary	Bio	Letters	Primary		
Burkina Faso	39	54	50	53	51	49	99	197
Cyprus	38	97	27	25	60	75	251	71
Algeria	24	37	46	39	34	43	158	65
Estonia	31	31	31	29	30	30	153	29
Finland	66	28	32	55	69	56	256	50
France	100	110	114	149	101	158	557	175
Hungary	52	68	52	56	57	49	271	63
Italy	53	107	97	66	54	182	497	62
Lebanon	153	111	246	59	56	97	593	129
Morocco	66	42	49	62	50	61	191	139
Portugal	49	61	67	53	61	59	286	64
Romania	44	42	46	49	45	47	237	36
Senegal	52	54	54	62	51	51	90	234
Tunisia	125	116	106	193	110	103	441	312

Table 1: Number of teachers from each country in the six teaching categories and in gender categories.

4.2.Questionnaire

The full questionnaire included 150 questions dealing with the 6 topics of the BIOHEAD-CITIZEN project, including personal information: not only gender, but also age, taught matter and several other questions related to religious, political, social or economical opinions. In consequence, it can be tested if the possible gender effect is a bias resulting from the eventual influence of other parameters.

We analyze here the answers to the 16 questions related to biological and / or social gender differences. Most of them are made to evaluate possible interactions between K and V: the link between biological determinism and sexist values (A36, A9, A14, A38, A46, A25, and A21), or between genetic determinism of social behaviour and innate values (B4 and A19). Others are linked only to sexist values (A2 and A30). The other questions are only dealing

with scientific knowledge: B33, B34, B35, and B36 are related to the nervous system and the cerebral epigenesis (which is the biological support of some personal features); B31 is related to a simple rule of genetic heredity.
All the questions used in this research are based on a Likert scale where each individual ticks one of the four boxes between "I agree" and "I don't agree" (Table 2).

A2.	In a modern society, men and women should have equal rights.	I agree					I don't agree
A9.	Women are less intelligent than men are because their brains are smaller than men's brains are.	I agree					I don't agree
A14.	Thanks to their physical features, men perform better in athletics than women do.	I agree					I don't agree
A19.	Due to identical genes, identical twins have identical brains and, therefore, identical behaviour and ways of thinking.	I agree					I don't agree
A21.	Biologically, women can be as intelligent as men.	I agree					I don't agree
A25.	It is for biological reasons that women cannot hold positions of as high responsibility as men can.	I agree					I don't agree
A30.	It is important that there are as many women as men in parliaments.	I agree					I don't agree
A31.	When a couple has already had two girls, the chances that their third child be a boy are higher.	I agree					I don't agree
A36.	Men might be more able to think logically than women, because men might have different brain bilateral symmetry.	I agree					I don't agree
A38.	It is for biological reasons that women more often than men take care of housekeeping.	I agree					I don't agree
A46.	Biologically, men cannot be as sensitive and emotional as women.	I agree					I don't agree
B4.	Human social behaviour is partly directed by genes.	I agree					I don't agree
B33.	I can explain what a synapse is	Yes					No
B34.	I can explain what a neural network is	Yes					No
B35.	I can explain what cerebral plasticity is	Yes					No
B36.	I can explain what cerebral epigenesis is	Yes					No

Table 2: Selected questions from the Biohead-Citizen questionnaire. Questions presented with the hierarchy used to collect the answers.

4.3.Analysis of the data

Data from these questionnaires were handled by multivariate analyses (Principal Component Analysis, Between-analysis and Principal Component Analysis with respect to orthogonal Instrumental Variables). All the analyses were made with the software R (2007). Generally this kind of statistical method is used in ecology (Escoufier 1987, Dolédec & Chessel 1987, 1989, Lebreton et al 1991) in order to obtain a general overview of the repartition of species, which is contingent to a lot of physical parameters. More precisely, we used 3 different methods:

- *Principal Component analysis* or *PCA* (Sabatier et al 1989) to know what is the general structure of the answers: do they vary according to the individual knowledge, or according to values or both?
- *Between analyses* (Dolédec & Chessel 1987, 1989) are used to differentiate groups of individuals (different countries, biologist or not, males or females) in order to show what are the questions which differentiate the most these groups.

Sometimes the differences between groups can be an artefact. For instance, the divergences between men and women could be due to the differences of biologists and not biologists inside these groups. With the Principal Component Analysis with respect to orthogonal Instrumental Variables (Lebreton et al 1991), we can suppress the effect of one group. For instance we suppress the effect of "biologist or non-biologist" to know if it is still a difference between men and women independently to the parameter "biologist or non-biologist".
- The last statistical analysis used in this research is focused on the significance of the differences between groups. *The Monte-Carlo test* (Romesburg, 1985) is a randomisation test: the R software changes randomly the belonging to a group for each individual and compares the results obtained randomly with the results of our sample.

5.Findings

5.1.Question A38: Is it for biological reasons that women take care of housekeeping?

When we propose the affirmation *"It is for biological reasons that women more often than men take care of housekeeping"* (question A38) the reactions are very different from one country to another one. Only 3% of interrogated French teachers agree ("*agree*" + "*rather agree"*) while 71% in Algeria (figure 1). Between these two poles, the percentage of teachers who agree with this proposition is comprised between 1/3 and 2/3 in most of the countries, with the exception of Cyprus (18%), Portugal and Italy (about 10%).

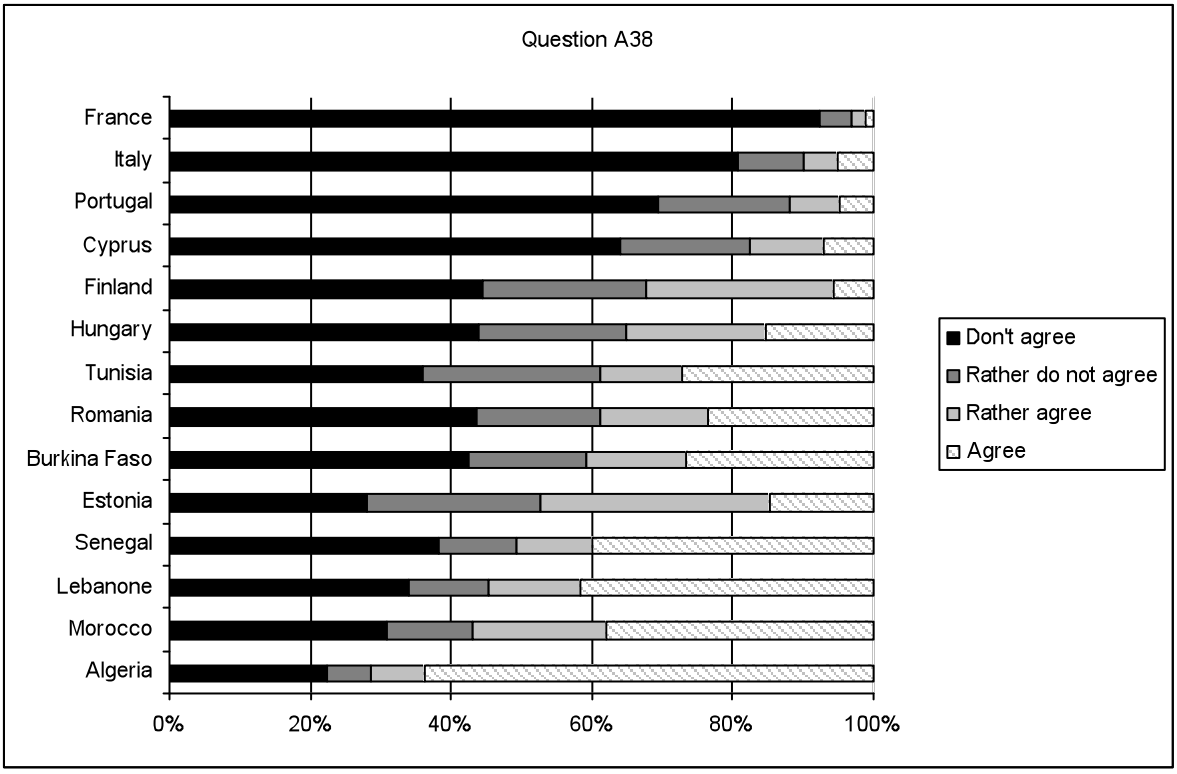

Figure 1: Answers to the question A38 (It is for biological reasons that women more often than men take care of housekeeping) for each country.

The 15 other questions could be analysed by this kind of descriptive histogram. Nevertheless, the *PCA* and the other methods presented in our methodology show more synthetic information in only one graph and they show the eventual correlations of the answers to all the 16 questions.

5.2.*Principal Component Analysis* (*PCA*): two main components: values and knowledge

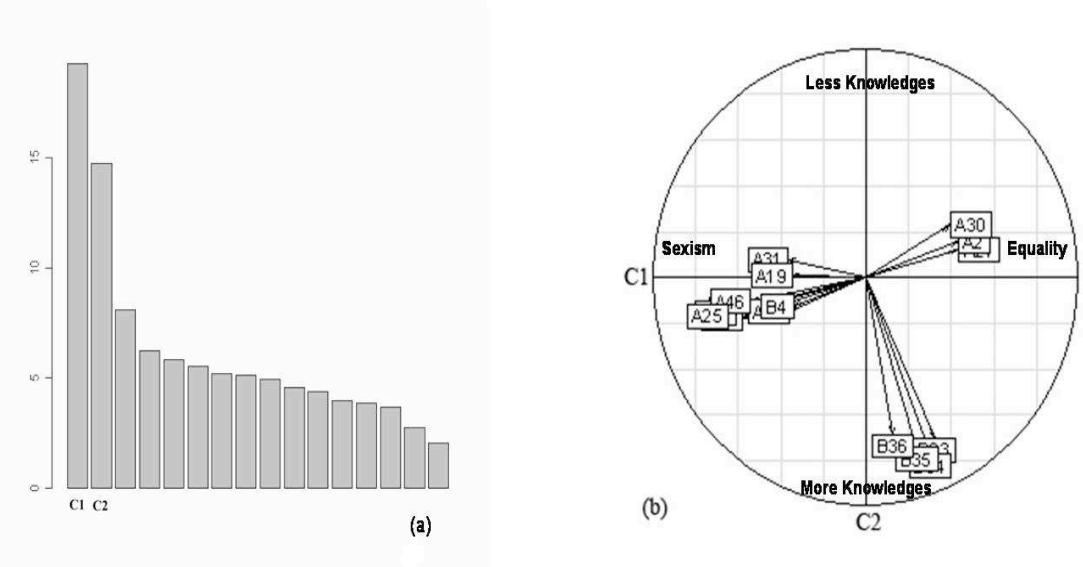

Figure 2: Principal Component Analysis (PCA) from the 5,706 in-service and pre-service teachers (14 countries) and the 16 variables on biological gender differences.
(a) The histogram of the proportion of variance for each component: the first two ones are the most informative(C1=19% and C2=14% of total variance). The other axes are considered as a background noise.
(b) The correlation circle shows that differences between the teachers' conceptions come from two independent axes: the axis of values (C1) and the axis of knowledge (C2).

The correlation circle shows how all individual teachers' conceptions are distributed according to their answers to the 16 questions. Each question is represented on correlation circles with the number of the question (B36, B35, etc.). More a question contribute to the variance more its corresponding arrow is long. The axis C1 is the most representative of the variation between the individual conceptions, the axis C2 is the second most representative.
The two questions dealing only with sexist social values (A2 and A30) are related to the axis C1, but this axis is also defined by all the KV questions, mainly A25, A9, A36, and A46. The conceptions expressed through these 4 last questions are strongly correlated (at the negative pole of the axis C1: figure 2b). In consequence, the axis C1 can be called the axis of values, and our results show a strong interaction between knowledge (K) and values (V), V being determining in this interaction. The hereditarianism (questions B4 and A19) is strongly linked to the sexism along this axis C1 (the component "values"). The answers to the question A31 (the chances that a third child be a boy), a priori related only to knowledge, are correlated to the sexist values.
A contrario, the answers to the 4 other questions related to knowledge (about nervous system and epigenesis: B33, B34, B35 and B36) are independent from values, defining the component C2 (the vertical axis in the figure 2b): being sexist or for equality between men and women, the teachers can have or not some knowledge on the nervous system and on the cerebral epigenesis, which are not known as the biological support or the social human behaviour, as already shown by Clément (1999). In consequence, for this precise knowledge, there is no interaction KV (between knowledge and values).

5.3.The difference between biologist and non-biologist teachers' conceptions

Some individuals of our sample learned biology to become a teacher: the pre-service and in-service teachers of biology but also some in-service and pre-service primary school teachers. All together, they form the group of 2,205 "biologist teachers", the 3,501 other teachers form the other group of "non-biologist" (pre-service letter teachers, in-service letter teachers, pre-service and in-service primary school teachers without degrees of biology).

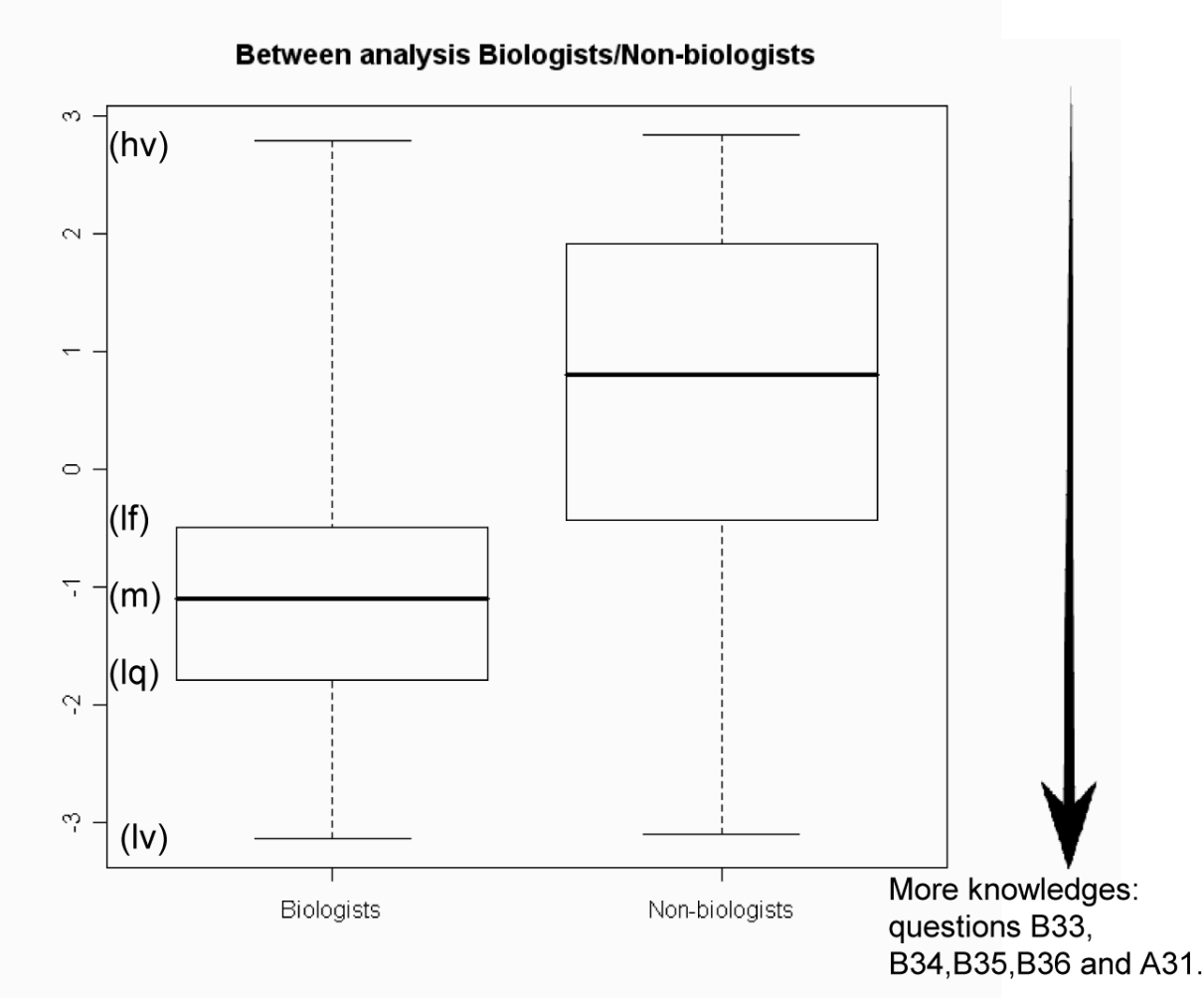

Figure 3: Between class analysis to differentiate biologist teachers to other teachers
The central line of each group is the median (m), lower (first) quartile (lq) is just under the median and the upper (third) quartile (uq) is at the bottom of median. And the extreme lines are the highly (hv) and the lowest values (lv). The vertical scale is the coordinate of individuals according to their answers to the 16 questions. More the coordinate is negative more individuals have knowledge.

The figure 3 shows a strong difference between biologist teachers and the other teachers (Monte Carlo test: $p < 0.001$). There is only one axis, mainly defined by the questions about knowledge (B33, B34, B35, B36, and, a little less, A31). Without surprise biologist teachers have more knowledge on nervous system and cerebral epigenesis, and also on the simple genetic rule (A31) than the non-biologist teachers. The two groups are not differentiated by their answers to the other questions related to values (V) or by interactions between knowledge and values (KV). The biologist teachers are not more sexist nor hereditarianist than the non-biologist teachers. Answering to the 8 questions with KV (A9, A14, A21, A25,

A36, A38, A46, and also B4 & B19), the knowledge (K) of any teacher is in accordance with his / her values (V).

5.4.A strong influence of the national context

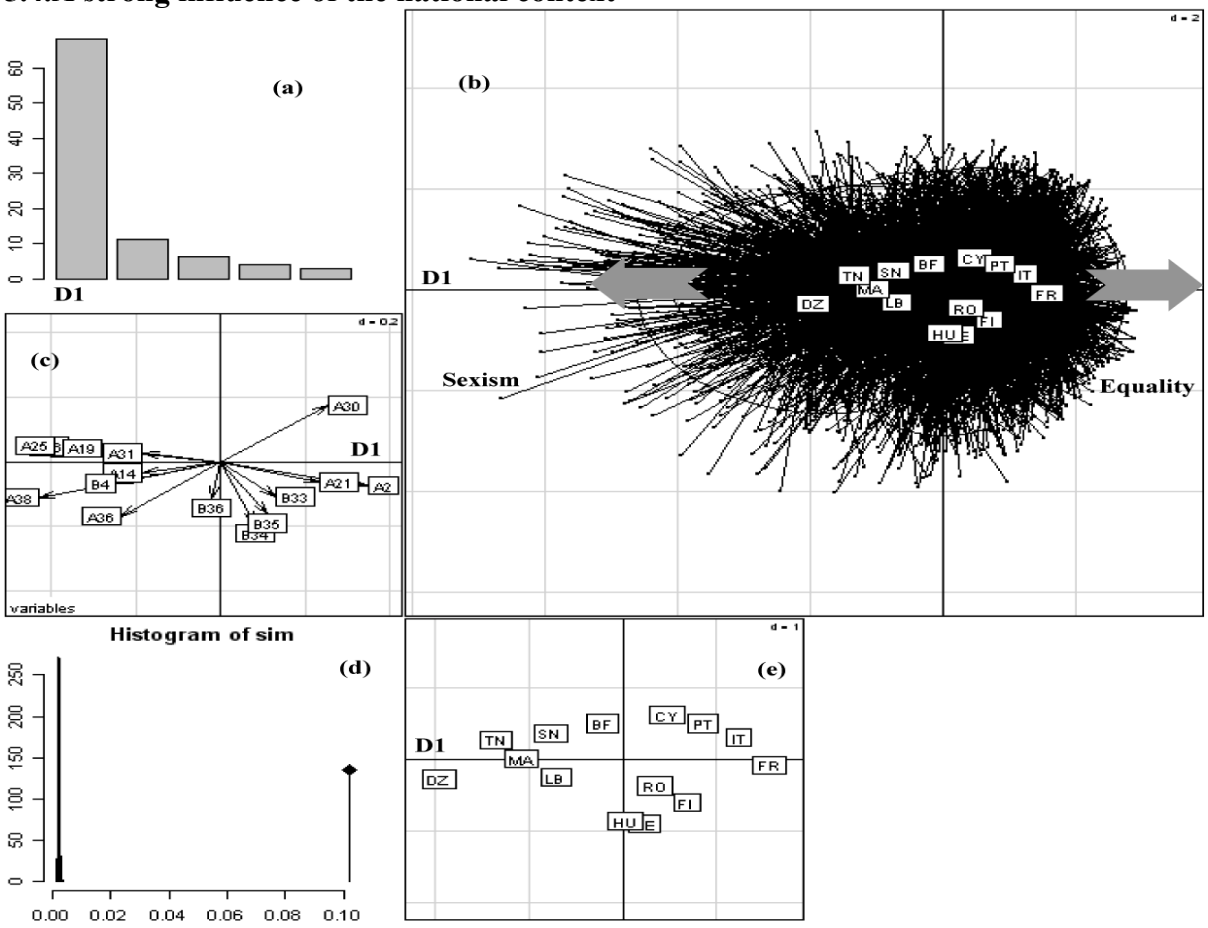

Figure 4*: Between-class analysis differentiating the 14 countries. From left (sexist conceptions) to right (equality between men and women) of the horizontal axis D1: DZ = Algeria, TN = Tunisia, MA = Morocco, SN = Senegal, LB = Lebanon, BF = Burkina Faso, HU = Hungary, EE = Estonia (hidden by HU), RO = Romania, CY = Cyprus, FI = Finland, PT = Portugal, IT = Italy, FR = France.*
(a), (b), (c), (d), (e): see the text for explanations

(a) Histogram of the percentage of variance of each component: the first one is the most important (D1). This component (D1) resumes almost all the information (68% of the variance). The other axes are considered as a background noise (nevertheless, the vertical axis D2 is a little linked to the questions on knowledge).
(b) and (e) Repartition of the teachers in the plane D1-D2, grouped by country. Each teacher is a dot, linked by a line to the centre of gravity of his / her own country. An ellipse is surrounding two thirds of the participants of each country, showing a relative diversity of conceptions inside each country, but also clear differences among the countries. From left (sexism) to right (equality), the projection of the centres of gravity of each country on the axis D1 (horizontal) shows that their rankings are: DZ = Algeria, TN = Tunisia, MA = Morocco, SN = Senegal, LB = Lebanon, BF = Burkina Faso, HU = Hungary, EE = Estonia, RO = Romania, CY = Cyprus, FI = Finland, PT =Portugal, IT = Italy, FR = France.
(c) Circle of correlation of the 16 variables in the plane defined by the two first components. The meaning is the same as in the figure 2 (initial PCA differentiating the teachers'

conceptions) at left the sexist ones and at right the conceptions for equality between men and women. Each arrow corresponds to the answers to a question. The most important questions differentiating the countries are A25, A38, A9, A36 and A2 (the questions on sexism) and the questions on hereditarianism (B4 and A19). These results clearly show a correlation between the teachers' sexism and the level of economical development of the country: they are more sexist in the less developed countries. Moreover the vectors of the questions on knowledge are very short, showing no difference between countries related to this knowledge.
(d) The randomization test (Monte Carlo) shows that the observed distribution (the dot on the right) is totally outside the histogram built from 1000 essays by chance (on the left). The differences among the 14 countries are strongly significant. This test assigns a new nationality to each individual at random and the variance is calculated between these new groups formed. The operation is repeated 1000 times and all the calculated variances are shown by the Bar plot (on the left). The trait at the right of the bar plot is the variance of our sample. The difference between the variance of our sample and the variance resulting from random dispersions show that the difference observed between countries is not random.
The countries where the tendency to be sexist is the most important are at the same time the less developed and those where almost all the teachers are Muslim. To try to separate these two possible effects, we have analysed a country (Burkina Faso) where Muslims and Christians are significantly represented in our sample: there is no significant difference between Christians and Muslims teachers (Monte Carlo test after a between analysis with the 9 questions merely linked to sexism).
Moreover a between analysis on Muslim teachers' conceptions coming from Senegal, Morocco, Algeria, Tunisia and Lebanon show large and strongly significant difference between them (Monte Carlo test $p<0.001$).
In consequence, the effect of the country is more important than the effect of the religion, and seems to be linked to the economical level of the country.

5.5.A clear gender effect

The between analysis has been done to differentiate female from male teachers' conceptions. It shows that female teachers are generally agree more than male teachers with equality between men and women. Women have a tendency to agree with A30, A2 and to disagree with A9, A14, A25, A21 which are the most influencing questions (there is only one axis in this analysis). Men disagree with A30, A2 and agree with A9, A14, A25, A21. This difference is strongly significant ($p < 0.001$, Monte Carlos test). The answers to the questions related to knowledge do not differentiate women and men.
The amount of males / females was not the same from one country to another (more males in Senegal for instance), nor into the 6 samples in each country. That’s why we used also a Principal Component Analysis with respect to Orthogonal Instrumental Variables (PCAVOI), to suppress the “training group” effect and the country effect. The gender effect is still very significant ($p < 0.001$) even when the influence of the countries and the influence of “training group” are suppressed. We can conclude that the differences between male and female teachers' conceptions are linked to values (and not linked to knowledge). Female teachers are significantly less sexist than male teachers.
Furthermore, the figure 5 (5c and more precisely 5d) shows that this gender effect is clearly present inside each country. On the axis E1 women are always more at left than men: female teachers agree more with the equality of rights between men and women (A2), with the equality in the number of men and women in parliaments (A30), and they think more that biologically women can be as intelligent as men (A21). The axis C1 is structured by the sexist answers: in the figure 5d, more the link between male teachers and female teachers is

horizontal more the difference between men and women is related to the questions inside the same country.

The weight of axis E2 is lower than the weight of the axis E1 (Fig.5a) and is explained by the questions A30, A36 (*Men might be more able to think logically than women, because men might have different brain bilateral symmetry*) and A14 (*Thanks to their physical features, men perform better in athletics than women do)*, which are also dealing with sexist values.

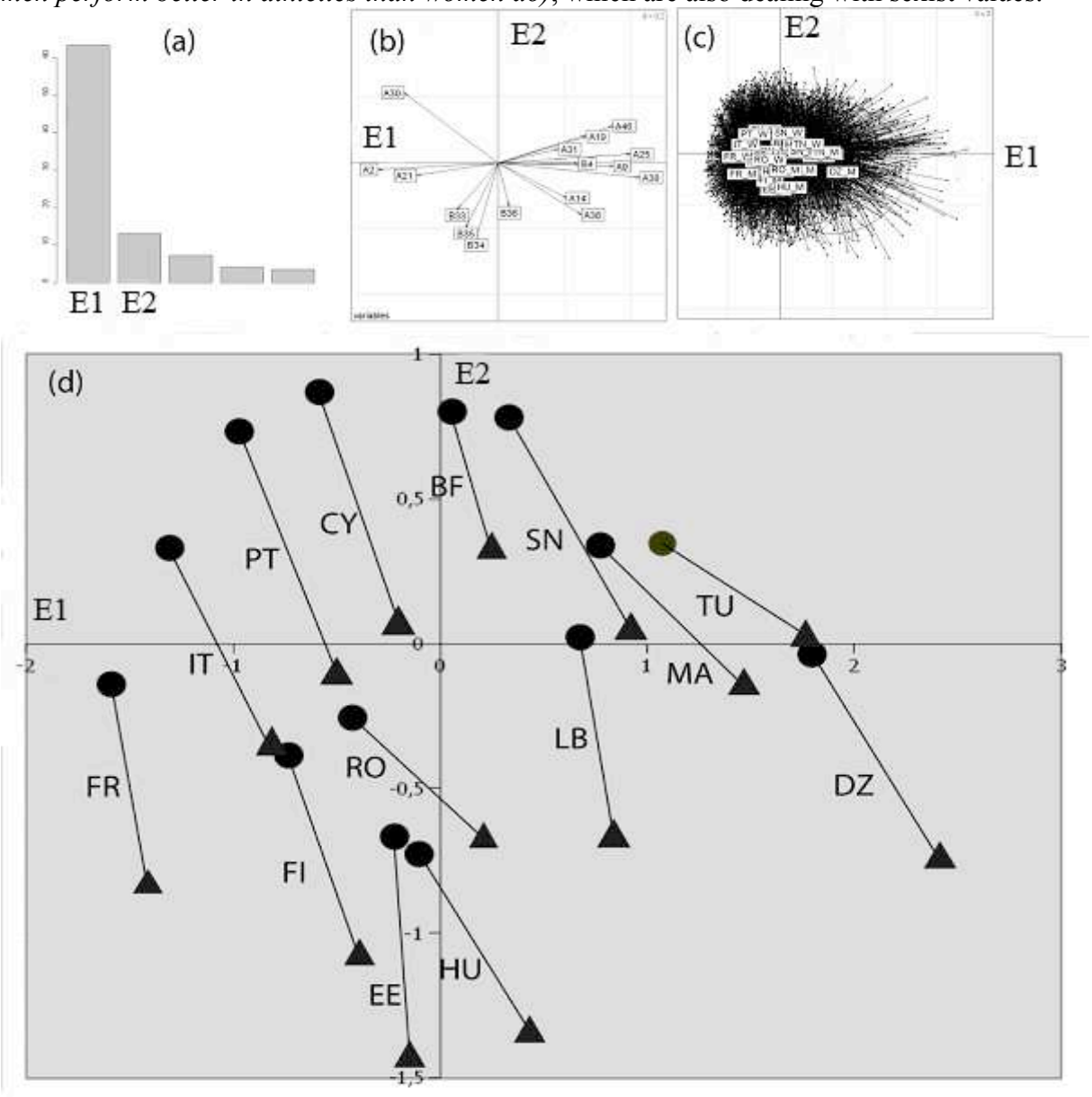

Figure 5: Between class analysis to differentiate female from male teachers in each country.
(a) Histogram of the percentage of variance.
(b) Circle of correlation of the 16 variables.
(c) and (e) Repartition of the teachers in the plane B1-B2.
DZ = Algeria, TN = Tunisia, MA = Morocco, SN = Senegal, LB = Lebanon, BF = Burkina Faso, HU = Hungary, EE = Estonia, RO = Romania, CY = Cyprus, FI = Finland, PT = Portugal, IT = Italy, FR = France.
▲*= Gravity center of males teachers*
●*= Gravity center of females teachers*

All the questions related to sexism show this clear gender effect, except one, the question A46 proposing that women are “more sensitive and emotional” than men: only for this question there is no significant difference between men' and women's answers (Pearson's Chi-squared test, p-value=0.41), 50% of the total sample agree with this proposition, 13% rather agree, 13% rather do not agree and 24% do not agree at all.

6.Discussion

Firstly, our research shows that the values (V) are more important than the knowledge (K) concerning the teachers' conceptions related to the biological support of sexism and to the equality between men and women. For 9 of our 16 questions, there was an interaction between K (knowledge on the biological determinism of gender differences, or on genetic processes) and V (sexist values, or hereditarianism): the values determined more the teachers' answers, the biological knowledge just being a justification of their values.
Nevertheless, this link between K and V was not found in the answers to the 4 questions related to nervous system and cerebral epigenesis, apparently because the teachers did not know this biological support of the socio-cultural differences between men and women. Kochkar (2007, p.306) showed that after learning cerebral epigenesis and nervous system, learners (including pre-service teachers) significantly moved away from a strict biological determinism (hereditarianism and sexism).
The second result is related to the strong differences between countries: the teachers' sexism, linked to their hereditarianism, is more frequent in the less developed countries. Dambrun (2007) and Keller (2005) already discussed that hereditarianism is linked to intolerant beliefs, here sexism. Our results suggest another link, with the economical development of the country. Sexism is more present in the non-European countries but also inside Europe. They are more present in the ex-USSR countries than in the oldest countries of the European Community (as France and Italy). The influence of the national context is very strong, and is not limited to the economical level of development of the country. Moreover, these results just indicate great tendencies, the main characteristics of each country, showing also large variations inside each country. We also did other analyses of our data, not presented here, showing for instance that inside a country as Burkina Faso there is no difference between Muslim and Christian teachers). Inside France, most of the Christian teachers are not sexist. In consequence, the country effect is more important than the effect of religion: aware that religion is very linked to the culture (Winter 2006a & 2006b), our results show that the sexist conceptions cannot be reduced to the effect of religion.
Finally, our results also show a clear significant gender effect, independently to the others significant effects (the nationality and the training group). Female teachers have tendency to be more anti-sexist than their male colleagues. This gender effect is present inside of each one of the 14 countries. In their book, Nelkin and Lindee (1998, p.162) claimed that the biological explanations are inclined to comfort the groups which feel to be menaced. Our results can also be interpreted as women agreeing more with affirmations that give more equality for their own group, when men disagree, and reciprocally. Only the answers to the question related to sensitivity and emotion (A46) shows no gender effect: is it because there would be a consensual cultural, sociological or even biological support or because women as men could take advantage from this possible gender difference?

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References

Atlan, H. (1999) *La fin du "tout génétique"*. Paris: INRA.

Biology, Health and Environmental Education for better Citizenship. (2004) Coordinated by Carvalho, G., Clément P., Bogner F. European Research Project (FP6, Priority 7). DOI: http://www.biohead-citizen.net/

Canguilhem, G. (1981) *Idéologie et rationalité dans l'histoire des sciences de la vie*. Paris : Librairie philosophique J. Vrin.

Chemin, A. (2007) Egalité hommes - femmes : la France peut mieux faire. *Le Monde* 27 nov. 2007, pp.22.

Clément, P. (1999). Situated conceptions. Theory and methodology. From the collection of data (on the brain) to the analyse of conceptions. in M. Méheut & G. Rebmann (Eds.), *Fourth European Science Education Summerschool : Theory, Methodology and Results of Research in Science Education* (pp. 298-315).. ESERA, SOCRATES, U.Paris 7.

Clément, P. (2004) Science et idéologie : exemples en didactique et épistémologie de la biologie. Actes du Colloque *Sciences, médias et société*. ENS-LSH, pp.53-69. http://sciences-medias.ens-lsh.fr

Clément, P. (2006) Didactic Transposition and the KVP Modèle: Conceptions as Interactions Between Scientific Knowledge, Values and Social Practices. *Proceedings Summer School ESERA*, IEC, Univ. Minho (Portugal), pp. 9-18.

Dambrun, M., Kamiejski, R., Haddadi N & Duarte S. (2007) Running Head : university socialisation, Genetiscim and SDO. *European Journal of Social Psychology*, In press (available at http://www3.interscience.wiley.com/cgi-bin/fulltext/117916457/PDFSTART)

Dolédec, S. & Chessel, D. (1987) Rythmes saisonniers et composantes stationnelles en milieu aquatique I- Description d'un plan d'observations complet par projection de variables. *Acta OEcologica, OEcologia Generalis*, 8, 403-426.

Dolédec, S. & Chessel, D. (1989) Rythmes saisonniers et composantes stationnelles en milieu aquatique II- Prise en compte et élimination d'effets dans un tableau faunistique. *Acta OEcologica, OEcologia Generalis*, 10, 207-232.

Escoufier, Y. (1987). The duality diagram: a means of better practical applications. In P. Legendre & L. Legendre (Eds.), *Development in numerical ecology* (pp.139-156). Berlin: Springer Verlag.

Jacquard, A. & Kahn, A. (2001) *L'avenir n'est pas écrit*. Paris: Bayard.

Keller, J. (2005). In genes we trust: The biological component of psychological essentialism and its relationships to mechanisms of motivated social cognition. *Journal of Personality and Social Psychology*, 88, 686-702.

Kochkar, M. (2007). Les déterminismes biologiques. Analyse des conceptions et des changements conceptuels consécutifs à un enseignement sur l'épigenèse cérébrale chez des enseignants et des apprenants tunisiens, Thèse Doctorat Université Lyon 1 & ISEFC, Université de Tunis.

Kupiec, J.-J. & Sonigo, P. (2000). *Ni Dieu, ni gène*. Paris: Seuil.

Lebreton, J.D., Sabatier R., Banco G. & Bacou A.M. (1991). Principal component and correspondence analyses with respect to instrumental variables : an overview of their role in studies of structure-activity and species-environment relationships. In J. Devilliers & W. Karcher (Eds.), *Applied Multivariate Analysis in SAR and Environmental Studies* (pp.85-114). Kluwer Academic Publishers.

Nelkin, D. & Lindee, S. (1998). *La mystique de l'ADN*. Paris: Belin.

PISA. (2003). Learning for tomorrow's world: First results from PISA 2003: Paris: OECD.

R Development Core Team. (2007). R: A language and environment for statistical computing. R Foundation for Statistical Computing. Vienna, Austria. ISBN 3-900051-07-0, URL http://www.R-project.org

Romesburg, H. C. (1985). Exploring, confirming, and randomization tests. *Computers & Geosciences,* 11, 19-37.

Sabatier, R., Lebreton, J. D. & Chessel, D. (1989). Principal component analysis with instrumental variables as a tool for modelling composition data. In R. Coppi & S. Bolasco, (Eds.) *Multiway data analysis* (pp. 341-352). Elsevier Science Publishers B.V., North-Holland.

Schreiner, C. & Sjoberg, S. (2007) Science education and youth's identity construction. Two incompatible projects? In D. Corrigan, J. Dillon & R. Gunstone (Eds.), *The Re-Emergence of Values in Science Education* (pp.231-247). Rotterdamm: Sense Publishers.

Sorensen, H. (2007) Gender inclusive Science Education? In D. Corrigan, J. Dillon & R. Gunstone (Eds.), *The Re-Emergence of Values in Science Education* (pp. 249-267). Rotterdamm: Sense Publishers.

Stewart, J. (1993) Au delà de l'inné et de l'acquis. *Intellectica*, 16, 151-174.

Winter, B. (2006a) Religion, culture and women's human rights: Some general political and theoretical considerations. *Women's Studies International Forum,* 29, 381-393.

Winter, B. (2006b). Gender and religion. In K. Davis, M. Evans & J. Lorber (Eds.), *Handbook of gender and women's studies* (pp. 93-108). London: Sage Publications.